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INFLUENCE OF SEED PRIMING ON PHYSIOLOGICAL PERFORMANCE OF FOXTAIL, LITTLE AND PROSO MILLETS

SRIDEVI R[1] & MANONMANI V[2]

[1]*Research Scholar, Department of Seed Science and Technology,*

Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

[2]*Professor, Department of Seed Science and Technology,*

Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

ABSTRACT

Seed priming is a widely recommended pre sowing seed treatment, proven for its invigourative effect. An investigation was carried out to study the effect of priming on physiological seed quality parameters. Seeds of foxtail millet cv. CO7, little millet cv. CO 4 and proso millet cv. CO (PV) 5 were primed with water, KH_2PO_4 2 % and Pseudomonas fluorescens 20 % and evaluated for their physiological quality along with non-primed control. Among the given treatments, foxtail millet, little millet and proso millet seeds primed with Pseudomonas fluorescens 20 % for 8 h showed early germination, higher germination, shoot and root length, dry matter production, vigour index and seed metabolic efficiency than seeds primed with KH_2PO_4, 2 %, hydroprimed and non-primed seeds.

KEYWORDS: Seed Priming, Foxtail Millet, Little Millet, Proso Millet, Germination, Vigour

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Original Article

INTRODUCTION

Millets – The Miracle Grains are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Small millets are a group of grassy plants with short slender culm and small grains possessing remarkable ability to survive under adverse conditions like limited rainfall, poor soil fertility and land terrain making them an attractive crop for marginal farming environments.

Seed is a basic input in agriculture in which 25 % yield increase can be achieved by quality seeds. Quality seed is the key for successful agriculture, which demands each and every seed should be readily germinable and produce a vigorous seedling ensuring higher yield. To provide higher quality seeds, many researchers have developed new technologies called “Seed Enhancement Techniques”.

Seed priming is one among the seed quality enhancement technique, in which seeds are partially hydrated until the germination process begins, but radicle emergence does not occur (Bradford, 1986). Seed priming is a controlled hydration process followed by redrying that allows seed to imbibe water and begin internal biological processes necessary for germination, but which does not allow the seeds to actually germinate. In seed priming, the amount of water absorption is controlled so as necessary metabolic activities occurred for germination, but radical emergence is prohibited. This technique is used for improvement of germination speed, germination vigour, seedling establishment and yield (Talebian *et al*., 2008). Kokila (2014) revealed that seeds of rice hybrid CORH 4 and its parental lines COMS 23A and CB 174R bioprimed with 4 % *P. fluorescens* for 12 h or 20 % liquid

Azospirillum for 12 h or 15 % liquid phosphobacteria for 12 h or 20 % liquid Azophos for 12 h had registered earlier germination, higher germination percentage, longest root and shoot, maximum dry matter production and vigour index than hydroprimed and control seeds.

Hence, the study was undertaken to evaluate the effect of seed priming on foxtail millet, little millet and proso millet.

MATERIALS AND METHODS

Genetically pure seeds of foxtail millet cv. CO 7 (*Setaria italica* Beauv.), little millet cv. CO 4 (*Panicum miliare* L.) and proso millet cv. CO (PV) 5 (*Panicum miliaceum* L.) obtained from the Department of Millets, Tamil Nadu Agricultural University, Coimbatore formed the base material for the present investigation. The foxtail millet, little millet and proso millet seeds were primed in water, KH_2PO_4 2 % and *Pseudomonas fluorescens* 20 % with the seed to solution ratio (w/v) of 1:1 for 8 h under ambient conditions (28-30^{0}C). After soaking for specified duration, seeds were removed from the solutions and shade dried at room temperature to bring back to original moisture content. The non primed seeds were used as control. The control and treated seeds were evaluated for the following physiological seed quality parameters.

Speed of Germination

Four replicates of twenty five seeds in each of the treatments and crops were germinated in petriplates adopting the top of the paper method as per ISTA (2007). The seeds showing radicle protrusion were counted daily from the date of sowing upto the completion of cumulative germination. Based on the number of seeds germinated in percentage on each of the day, the speed of germination was calculated using the following formula and the results were expressed as number (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + ... + \frac{X_n - X_{n-1}}{Y_n}$$

X_1: Percentage of seeds germinated at first count

X_2: Percentage of seeds germinated at second count

X_n: Percentage of seeds germinated on n^{th} day

Y_1: Number of days from sowing to first count

Y_2: Number of days from sowing to second count

Y_n: Number of days from sowing to n^{th} count

Germination

The germination test was carried out in roll towel medium using 4 x 100 seeds (ISTA, 2007) in a germination room maintained at 25 ± 2°C temperature and 95 ± 3 % RH. After the germination period of seven days for proso millet and after 10 days for foxtail millet and little millet the seedlings were evaluated as normal seedling, abnormal seedling, hard seed and dead seed. Based on normal seedlings, the germination was calculated adopting the following formula and the mean expressed as percentage.

$$\text{Germination (\%)} = \frac{\text{Number of Normal Seedlings}}{\text{Total Number of Seeds Sown}} \times 100$$

Root Length

At the time of germination count, ten normal seedlings were selected at random from each of the crops and used for measuring the root length of seedlings. Root length was measured from the collar region to the tip of primary root. The mean values were calculated and expressed in centimetre.

Shoot Length

The seedlings used for measuring root length were also used for measuring shoot length. The shoot length was measured from the collar region to the tip of the primary leaves and the mean values were expressed in centimetre.

Dry Matter Production

Ten normal seedlings were selected randomly from each of the crops and dried in shade for 24 h and were kept in an oven maintained at 85^0C for 24 h. After the drying period, the seedlings were cooled in closed desiccator for 30 minutes and were weighed in a top pan balance and the mean expressed as g seedlings^{-10} (Gupta, 1993).

Vigour Index

Vigour index (VI) was calculated using the method suggested by Abdul–Baki and Anderson (1973) and expressed in whole number.

VI = Germination (%) x [Root length (cm) + Shoot length (cm)].

Endosperm and Embryo Degradation (Seed Metabolic Efficiency)

Seed Metabolic Efficiency (SME) may be defined as the amount of shoot and root drymatter (g) produced from 1 unit (g) of dry seed weight that was respired. Thus higher the value of Seed Metabolic Efficiency, the higher is the efficiency of seed as more seed reserves would be used for producing roots and shoots. Amount of seed respired (SMR) was calculated as below,

SMR = SDW-(SHW+RTW+RSW)

Where,

SDW - Seed dry weight before germination

SHW - Shoot dry weight

RTW - Root dry weight

RSW - Remaining seed dry weight

Seed Metabolic Efficiency (SME) was calculated using the following formula (Rao and Sinha, 1993).

$$SME = \frac{SHW + RTW}{SMR}$$

Table 1: Influence of Seed Priming on Physiological Traits in Foxtail Millet cv. CO (Te) 7

Treatments	Speed of Germination	Germination (%)	Root Length (cm)	Shoot Length (cm)	DMP (g Seedlings^{-10})	Vigour Index	Seed Metabolic Efficiency
T_0 - Control	17.83	82 (64.90)	9.67	5.92	0.019	1278	1.283
T_1 - Hydropriming	19.45	83 (65.65)	10.32	6.12	0.020	1365	1.312
T_2 - Seed priming with KH_2PO_4 2 %	20.83	86 (68.03)	10.79	6.25	0.022	1465	1.382
T_3 - Seed priming with *P. fluorescens* 20 %	21.53	90 (71.57)	11.28	6.60	0.023	1609	1.553
Mean	19.91	85 (67.21)	10.51	6.22	0.021	1429	1.382
SEd	0.1411	0.4921	0.0737	0.0440	0.0001	10.0344	0.0096
CD (P= 0.05)	0.2991	1.0433	0.1563	0.0933	0.0003	21.2724	0.0204

Values in the parenthesis are arcsine transformed values

Table 2: Influence of Seed Priming on Physiological Seed Quality Traits in Little Millet cv. CO4

Treatments	Speed of Germination	Germination (%)	Root Length (cm)	Shoot Length (cm)	DMP (g Seedlings^{-10})	Vigour Index	Seed Metabolic Efficiency
T_0 - Control	17.83	79 (62.73)	6.94	5.68	0.016	997	1.328
T_1 - Hydropriming	18.16	83 (65.65)	7.21	6.15	0.018	1109	1.418
T_2 - Seed priming with KH_2PO_4 2 %	18.68	85 (67.22)	7.39	6.49	0.019	1180	1.468
T_3 - Seed priming with *P. fluorescens* 20 %	19.51	88 (69.73)	7.87	6.92	0.020	1302	1.557
Mean	18.54	83 (65.65)	7.35	6.31	0.018	1147	1.442
SEd	0.1286	0.4683	0.0515	0.0445	0.0001	8.0740	0.0101
CD (P= 0.05)	0.2727	0.9928	0.1092	0.0944	0.0003	17.1164	0.0214

Values in the parenthesis are arcsine transformed values

Table 3: Influence of Seed Priming on Physiological Seed Quality Traits in Proso Millet cv. CO (PV) 5

Treatments	Speed of Germination	Germination (%)	Root Length (cm)	Shoot Length (cm)	DMP (G Seedlings^{-10})	Vigour Index	Seed Metabolic Efficiency
T_0 - Control	18.33	85 (67.22)	10.56	6.53	0.032	1453	0.963
T_1 - Hydropriming	19.15	87 (68.87)	10.89	6.92	0.033	1549	1.122
T_2 - Seed priming with KH_2PO_4 2 %	19.60	88 (69.73)	11.04	7.14	0.035	1600	1.151
T_3 - Seed priming with *P. fluorescens* 20 %	20.33	90 (71.57)	11.54	7.50	0.039	1714	1.206
Mean	19.35	87 (68.87)	11.00	7.02	0.034	1579	1.110
SEd	0.1359	0.5376	0.0766	0.0495	0.0002	11.0268	0.0079
CD (P= 0.05)	0.2881	1.1396	0.1623	0.1050	0.0005	23.3761	0.0167

Values in the parenthesis are arcsine transformed values

RESULTS AND DISCUSSIONS

In foxtail, little and proso millet, statistically significant variation was observed for speed of germination, germination, root and shoot length, dry matter production, vigour index and seed metabolic efficiency due to priming treatments. The foxtail, little and proso millet seeds primed with *Pseudomonas fluorescens* 20 % for 8 h registered higher speed of germination (21.53, 19.51 and 20.33, respectively) (Table 1, 2, 3) and germination (90, 88 and 90 respectively) than nonprimed seed. An increase of 8.8, 10.2 and 5.5 %, respectively was noticed for germination due to *Pseudomonas fluorescens* priming over nonprimed seed. *Pseudomonas fluorescens* 20 % primed seeds for 8 h of foxtail, little and proso millets measured the longest root (11.28, 7.87 and 11.54 cm, respectively) and shoot (6.60, 6.92 and 7.50 cm, respectively). (Plate 1). Shortest root (9.67, 6.94 and 10.56 cm, respectively) and shoot (5.92, 5.68 and 6.53 cm, respectively) was observed in nonprimed seed. The foxtail, little and proso millet seeds primed with *Pseudomonas fluorescens* 20 % for 8 h produced higher dry matter production (0.023, 0.020 and 0.039 g seedlings^{-10}, respectively). The dry matter production was lower in nonprimed seeds (0.019, 0.016 and 0.032 g seedlings^{-10}, respectively) (Table 1, 2, 3). The vigour index was higher in foxtail, little and proso millet seeds primed with *Pseudomonas fluorescens* 20 % (1609, 1302 and 1714, respectively) when compared to other treatments. Figure 1. The vigour index value of control was (1278, 997 and 1453, respectively). *Pseudomonas fluorescens* 20 % primed seeds for 8 h of foxtail, little and proso millets also registered more seed metabolic efficiency of (1.553, 1.557 and 1.206, respectively).

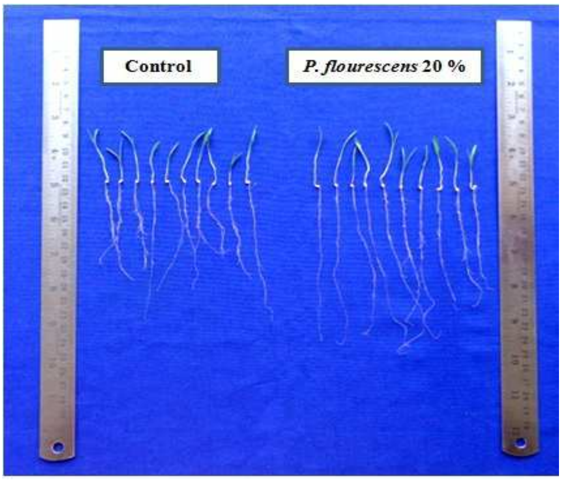

Plate 1: Seedling Growth of Primed Seeds of Foxtail Millet

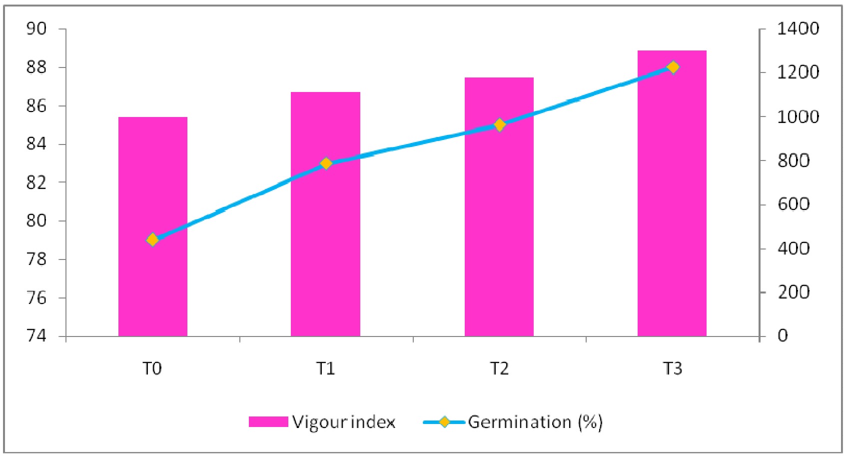

Figure 1: Germination and Vigour Index of Primed Seeds of Little Millet

The highest germination recorded in the present study might be due to the fact that the primed seed with *Pseudomonas fluorescens* 20 % for 8 h showed increase in the seed metabolic efficiency when compared to nonprimed seeds. The higher metabolic efficiency leading to mobilization of reserve food to the embryo for early initiation of germination was reported by many researchers (Wellman, 1961; Atia *et al.*, 2006; Job *et al.*, 2000). Biswas (1994) and Asch *et al.* (1999) stated that the mobilization rates known to affect the germination and seedling growth.

Similar effectiveness of priming with *P. fluorescens* was evident in improving the seed germination and seedling vigour in pearl millet by Raj *et al.* (2004). The enhancement in the seedling growth noticed in this study could be attributed to suppressions of deleterious microorganisms and pathogens; production of plant growth regulators such as gibberellins, cytokinins and indole acetic acid, which increased the availability of minerals and other ions and more water uptake (Ramamoorthy *et al.*, 2000).

The significant and faster rate of radicle emergence and radicle length noticed in the primed seed of the present investigation might be attributed to the quicker uptake of water coupled with early initiation of high metabolic changes. This fact is also supported by Ghassemi-Golezanik *et al.* (2008) in lentil who observed early radicle protrusion due to priming. Higher radicle length in bioprimed seeds observed in this study is also corroborated with the findings of Dezfuli *et al.* (2008) in maize and Afzal *et al.* (2009) in tomato. They measured higher radicle length in the primed seeds.

The beneficial effects of *Pseudomonas fluorescens* 20 % priming for 8 h on germination and seedling vigour expressed in this study might be the result of a synergism of priming effect with bacterial effect, since priming confers benefits such as completion of early germination phases, increasing the population of bioprotectants, rapid and uniform seedling emergence, facilitation of uptake of water and nutrients, protection against pathogens, potential defense responses such as early oxidation burst, incorporation of various phenolic compounds and polymers to the cell wall and secretion of phytoalexins (Musa *et al.*, 1999; 2001; Mathre *et al.*, 1999; Conrath *et al.*, 2002).

CONCLUSIONS

The foxtail, little and proso millet seeds primed with *P. fluorescens* 20 % for 8 h showed higher germination, shoot and root length, dry matter production, vigour index and seed metabolic efficiency. The *P. fluorescens* have the potential to proliferate, colonize and producing plant growth regulators during priming procedures. This is a eco-friendly technique for sustainable agriculture.

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